substance between the bone chips and between the contents of the cavity and the surrounding tissues.

6. In the treatment of an aseptic bone cavity by implantation of chips of antiseptic decalcified bone, the packing answers the purpose of an antiseptic tampon and furnishes the best medium for the growth and development of the tissue resulting from the regenerative process initiated by the trauma.

7. Secondary implantation can be successfully practised in the treatment of a suppurating bone cavity after suppuration has ceased, and the cavity can be transformed into the same favorable conditions for healing as an aseptic wound.

THE VALUE OF CREOLIN, HYDRONAPHTHOL, AND SODIUM FLUOSILICATE AS GERMICIDES.[1]

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Sodium fluosilicate and hydronaphthol are often used as germicides, but their germicidal properties, so far as I can learn, have never been demonstrated. They have both been shown to be efficient antiseptics.

The germicidal and antiseptic properties of creolin have been tested by Esmarch, Eisenberg, and others. It has been demonstrated to be a germicide of nearly equal power with carbolic acid.

The following experiments were undertaken to determine the germicidal power of sodium fluosilicate, hydronaphthol, and creolin as compared with one another and as compared with some of the older germicides which they tend to supplant, such as the bichloride, carbolic acid, and thymol.

Method.—The bacteria used to test the germicidal power were the bacillus typhosus, the pneumococcus (Friedländer's), the streptococcus erysipelatis (Fehleisen), the staphylococcus pyogenes aureus, and those of decomposing beef bouillon which had been previously sterilized and then exposed to the air of the laboratory for two weeks. Pure cultures were then made in sterile beef bouillon of the B. typhosus, streptococcus erysipelatis, and pneumococcus.

The staphylococcus pyogenes aureus does not grow readily in beef bouillon, therefore a pure culture of this was made in nutrient gelatine which had been steamed so long that it remained liquid. In this the staphylococcus grows abundantly.

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[1] The experiments given in this paper were performed in the bacteriological laboratory of the Yale Medical School.

Solutions were then made of the following germicides:

- Bichloride, 1 to 10,000.
- Bichloride, 1 to 2000.
- Carbolic acid, 2 per cent.
- Creolin, 2 per cent.
- Creolin, 1 to 1000.
- Hydronaphthol, saturated aqueous solntion (1 to 1150).
- Sodium fluosilicate, saturated aqueous solution (1 to 120).
- Sodium fluosilicate, 1 to 1000.
- Thymol, saturated aqueous solution (1 to 1200).
- Resorcin, 2 per cent.

One cubic centimetre of one of the antiseptics was placed in a sterilized test-tube with a sterilized pipette, and one cubic centimetre of one of the cultures was lowered with a sterilized pipette into the test-tube and allowed to flow into the antiseptic. Care was taken in introducing and withdrawing the pipette not to touch the sides of the test-tube. The tube was then plugged with sterilized cotton, and at the end of one-half hour and two hours, inoculations were made from it into tubes of sterilized beef bouillon, except in the case of the staphylococcus pyogenes aureus, when the inoculations were made into the fluid nutrient gelatine.

The inoculations were made by means of a long platinum needle, the end of which had been twisted into a spiral. With this a good-sized drop could be taken out of the culture which had been mixed with the germicide, and transferred to a test-tube of sterile beef bouillon.

The transfer, if properly manipulated, need take but a few seconds, and the cotton plugs are immediately replaced in the tubes. If the tubes are held well inclined toward a horizontal line, there is little danger of contamination from the air during manipulation. In fact, the danger of infection from any source other than the culture mixture is very slight. I have proved this by going through the same manipulation and inoculating sterile fluids into sterile bouillon. I have done this over fifty times and have never had one of the tubes of sterile bouillon break down.

The tubes of sterile beef bouillon which had been inoculated from the culture mixtures were then placed in an incubator and kept at a temperature of 40° C. (104° F.), and watch kept for the first signs of cloudiness, which indicates the growth of bacteria.

Since an equal part of the fluid culture was added to the solution of each antiseptic, this was diluted one-half and consequently the strength of each of the antiseptics tested was just one-half the strength of the original solution.

Two different strengths of sodium fluosilicate and creolin solutions were used, that the limits of their germicidal power might be roughly determined in case the stronger solution proved to be a germicide. A 1 to 2000 solution of the bichloride was used as a check, since if any tubes inoculated from mixtures of this broke down there would be a probability of some error in the method.

The fact that tubes inoculated from mixtures of this always remained sterile proved the absence of infection from without.

Conclusions.—Below is a table of the results obtained after an exposure of one-half hour and of two hours.

		Sodium fluosilicate, 1 to 2000.	Sodium fluosilicate, 1 to 240.	Thymol, 1 to 240.	Hydronaphthol, 1 to 2300.	Creolin, 1 to 2000.	Creolin, 1 per cent.	Bichloride, 1 to 20,000.	Bichloride, 1 to 4000.	Resorcin, 1 per cent.	Carbolic acid, 1 per cent.
Staphylococcus pyogenes aureus	½ hr.	Cloudy	Cloudy	Sterile	Cloudy	Cloudy	Sterile	Sterile	Sterile	Cloudy	Sterile
	2 hrs.	"	"	"	"	"	"	"	"	"	"
Pneumococcus	½ hr.	Cloudy	Cloudy	Sterile	Cloudy	Cloudy	Cloudy	Sterile	Sterile	Cloudy	Sterile
	2 hrs.	"	"	"	"	"	"	"	"	"	"
Streptococcus erysipelatis	½ hr.	Cloudy	Cloudy	Sterile	Cloudy	Cloudy	Sterile	Sterile	Sterile	Cloudy	Sterile
	2 hrs.	"	"	"	Sterile	"	"	"	"	"	"
Bacillus typhosus	½ hr.	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	Sterile	Sterile	Sterile	Cloudy	Sterile
	2 hrs.	"	"	Sterile	"	"	"	"	"	"	"
Beef bouillon	½ hr.	Cloudy	Cloudy	Sterile	Sterile	Cloudy	Sterile	Sterile	Sterile	Cloudy	Sterile
	2 hrs.	"	"	"	"	"	"	"	"	"	"

It will be observed that the only two germicides invariably sterilizing each culture are the two solutions of the bichloride (1 to 20,000 and 1 to 4000), and the solution of carbolic acid (1 per cent). It will further be observed that tubes inoculated from mixtures of sodium fluosilicate (1 to 2000 and 1 to 240), of resorcin (1 per cent.), and of creolin (1 to 2000) invariably broke down; consequently we may dismiss sodium fluosilicate, resorcin, and creolin (1 to 2000) from our consideration, with the conclusion that they are of little value as germicides.

The remaining ones to consider are creolin (one per cent.), thymol, and hydronaphthol; and of these thymol evidently ranks first, only one tube in ten breaking down. Creolin (one per cent.) ranks next, and appears to be a good germicide in a one per cent. solution, but not quite strong enough in this solution to destroy the pneumococcus, although efficient against the other bacteria used.

Hydronaphthol in a 1 to 2300 solution possesses a little germicidal power, three tubes out of ten remaining sterile.

Placing these antiseptics in the order of their germicidal powers in the strength of the solutions tested, we have:

(1) Bichloride, 1 to 20,000.
(2) Carbolic acid, 1 per cent.
(3) Thymol, 1 to 240.

(4) Creolin, 1 per cent.
(5) Hydronaphthol, 1 to 2300.
(6) { Sodium fluosilicate, 1 to 240.
Resorcin, 1 per cent.
Creolin, 1 to 2000.

USES.—Antiseptics are of value where long action is required to prevent the growth of bacteria while repair goes on in the tissues; they are, therefore, useful substances with which to impregnate surgical dressings. Germicides are useful where rapid action is demanded, and where the fluid remains in contact with the infected area for a short time only; they are therefore useful for irrigating wounds, for sprays, for douches, for washing the hands, and for the sterilization of instruments.

The term germicide implies sterilization, while the term antiseptic implies sepsis with retardation or absence of development.

An antiseptic, unless also a germicide, can be of no value, except as so much water, for washing a surgeon's hands or instruments, or for irrigating or douching.

This distinction needs to be observed, since many antiseptics, such as sodium fluosilicate and hydronaphthol, are used for douching, irrigating, washing hands and instruments, when sterilized water would be just as efficient and even more so, since antiseptic solutions may not themselves be sterile and consequently may convey infection.

Creolin, according to my experiments, ranks far above sodium fluosilicate and hydronaphthol. Though insoluble in water, it forms an emulsion with it which possesses all the antiseptic and germicidal properties of a solution. My experiments show it to have very nearly equal germicidal properties with carbolic acid, comparing equal per cent. solutions; but its toxic properties have been shown to be considerably less, and therefore its available germicidal strength is greater than that of carbolic acid.

Creolin has been used for sterilizing instruments, but there are certain objections to its use for this purpose. Being an opaque fluid, instruments put in it are found with difficulty during an operation; the same characteristic is an objection to its use for irrigating during operations, in that it obscures the parts operated upon. It also renders the handles of instruments slippery, as if they had been dipped in oil.

As carbolic acid can be used as strong as five per cent. for sterilizing instruments, it would seem to be the best germicide for this purpose, since it furnishes a clear solution which is a powerful germicide and does not injure surgical instruments.

Perhaps the best uses to which creolin can be put are for washing the hands and for vaginal douches. A five per cent. solution of creolin does not benumb the hands as carbolic acid does, and does not crack and roughen them as the bichloride does, but renders the skin smooth and supple.

The great value of vaginal and intra-uterine douches of the bichloride in the prophylaxis and treatment of puerperal septicæmia is undoubted. The mortality from puerperal septicæmia since their introduction has decreased from 5 per cent. to 0.34 per cent. There is, however, considerable danger of mercurial poisoning from their continued use. Stieffeck has reported cases of poisoning from douches of solutions of 1 to 3000 and 1 to 4000.

Virchow has reported a case of mercurial poisoning terminating in death, due to three intra-uterine douches, each containing one quart of a solution of 1 to 1000 of the bichloride, one douche being given each day for three successive days. The use of the bichloride douche in nephritis is always contraindicated.

Although the stronger solutions of the bichloride (1 to 1000 or 4000) are unsafe for continued intra-uterine douching, it would seem that a solution of 1 to 20,000 would be safe and efficient, especially if tartaric acid is added to the solution. A quart of this used in a douche would contain a little less than a grain of the bichloride, and since it would be held in solution by the tartaric acid, it would mostly flow away and not be precipitated on the endometrium.

Carbolic acid is often substituted for the bichloride for the intra-uterine douche, but it cannot be used stronger than three per cent., and even this for continued use would be unsafe.

A three per cent. solution of creolin thus far has proved a safe and efficient germicide for this purpose and a five per cent. solution can probably be used with safety. Creolin has the additional advantages of possessing hæmostatic properties and limiting secretions.

Creolin has been used in certain diseases of the eye and ear with success, but in solutions too weak to have any germicidal effect.

In conclusion, my investigations tend to show that for ordinary surgical use we have not in aqueous solutions of sodium fluosilicate and hydronaphthol germicides approaching in power weak solutions of the bichloride or one per cent. solutions of carbolic acid; that creolin possesses germicidal properties nearly equal to carbolic acid, and that it may properly be substituted for it for washing the hands and for intra-uterine and vaginal douches.